annual inequality to be an excess of 0′·227 of easterly declination in the months October to March over its value in the months April to September.

III. "On the Diurnal and Annual Inequalities of Terrestrial Magnetism, as deduced from observations made at the Royal Observatory, Greenwich, from 1858 to 1863; being a continuation of a communication on the Diurnal Inequalities from 1841 to 1857, printed in the Philosophical Transactions, 1863. With a Note on the Luno-diurnal and other Lunar Inequalities, as deduced from observations extending from 1848 to 1863." By GEORGE BIDDELL AIRY, Astronomer Royal. Received July 27, 1868.

(Abstract.)

The author states that the instruments employed are precisely the same which were used in the second part of the former investigation, from 1848 to 1857, mounted in the same place, and treated in the same manner. In describing the treatment of the photographic curves, he first gives the number of days which have been omitted in different years; because the character of the observations or curves was too disturbed to permit the usual treatment of the observations, or the drawing by hand of a pencil curve that would fairly represent the general course of the curve.

The greatest numbers of omitted days occur in the years 1846, 1847, 1848; 1851, 1852, 1853, 1854; 1859, 1860. As the estimate of the amount of irregularity has been made throughout by the same person, he considers that these years may be accepted as those in which the disturbances were the greatest. If they point to any cycle at all, it is one of 6 or $6\frac{1}{2}$ years. These days being omitted, the ordinates of the pencilled curves on the other days were used as basis of all the following investigations. For the solar inequalities, they were treated by collecting the measures for every complete solar day, or for every solar hour bearing the same ordinal number, according as the annual or diurnal inequalities were the subject of inquiry; but in all cases these quantities were next grouped by months, and the monthly means were taken.

In the further treatment, the means of the monthly means of every complete day for all the months of the same name in the different years were taken and corrected for secular change; the corrected numbers do not appear to indicate any sensible annual equation. Then the means of the monthly means of every solar hour for all the months of the same name in the different years were taken, giving the diurnal inequalities on the mean of years for the twelve separate months; and these present, for the declination (north to west) and horizontal force, for the period 1858 to 1863, sensibly the same differences between the summer months and the winter months as those for the period 1848 to 1857. For the vertical-force

curves also, the nodal passage in both periods is earliest in the summer months; but it is not quite certain whether the curves in autumn, in the period 1858 to 1863, are quite so bold as those in 1848 to 1857; the difference, however, if any, is inconsiderable. After this, the monthly means of every solar hour are taken through each year, giving the mean diurnal inequality of each year; and here a very remarkable change is observable. To explain this, it is necessary to refer to the former paper, where it is shown that the curves for diurnal inequality of the horizontal forces had very slightly increased from 1841 to 1847, but had rapidly diminished from 1848 to 1857, giving the smallest and most winter-like curves in 1856 and 1857. Now it is found that from 1858 to 1863 the curves have increased, with a little irregularity in 1861, till they are sensibly as large as they were at first. Thus—

| | | | |
|---|---|---|---|
| 1858 | nearly | resembles | 1856 |
| 1859 | ,, | ,, | 1851 |
| 1860 | ,, | ,, | 1850 |
| 1861 | ,, | ,, | 1851 |
| 1862 | ,, | ,, | 1847 |
| 1863 | ,, | ,, | 1841 |

With regard to the diurnal inequality of vertical force, it appears that the curves gradually increased in boldness to 1855, and have gradually diminished to 1862. The nodal passages, it was remarked in the former paper, had been much accelerated in the hour of the day, from 1842 to 1857. Now, from 1858 to 1863, the hours of nodal passages have been retarded, till in 1863 they are again nearly the same as in 1848. In all these remarkable changes there is no appearance of cycle.

The author then proceeds to the treatment of lunar inequalities from 1848 to 1863. The bases of their treatment were thus obtained: the exact time of moon's transit was laid down on the time-scales of the photographic sheet, and the intervals were divided into lunar hours, and a new system of ordinates, corresponding to the lunar hours, was measured to the pencil curves. The system of grouping was precisely similar, *mutatis mutandis*, to that for the solar inequalities. First, for the menstrual inequalities. The declination seems to exhibit a distinct lunar menstrual inequality, with + maximum about the fifth day of lunation; the horizontal force seems to show a lunar semimenstrual equation with — maximum about the second day; the vertical force shows nothing certain, proving only that, if there is anything, it is very small. Secondly, for the luno-diurnal inequalities. The luno-diurnal inequalities in declination and horizontal force on the mean of 1858 to 1863 agree so closely with those on the mean of 1848 to 1857, as to leave no doubt of their existence and law as luno-semidiurnal inequalities, with no trace of luno-diurnal or other inequality.

Remarking the singular difference for different years which has presented

itself in the discussion of the solar inequalities, it appeared to the author very desirable to examine whether there is any discoverable difference in the lunar inequalities for the same years. The years were accordingly thus divided:—

Large solar curves.. 1848 to 1852, 1859, 1860, 1862, 1863.
Small solar curves.. 1853 to 1858, 1861.

On discussing these, it was found that in all cases the lunar horary epoch for the inequality was sensibly the same for years of large solar curves and for years of small solar curves; but the coefficient was different. The value of the fraction

$$\frac{\text{lunar semidiurnal inequality in years of large solar curves}}{\text{lunar semidiurnal inequality in years of small solar curves}}$$

is

For declination ..... 1·35
For horizontal force ..... 1·25

The author remarks that it would seem possible to suggest two conjectural reasons for this remarkable association in the time-law of changes of solar effect and lunar effect. One is, that the moon's magnetic action is really produced by the sun's magnetic action; and a failure in the sun's magnetic power will make itself sensible, both in its direct effect on our magnets and in its indirect effect through the intermediation of the moon's excited magnetism. The other is that, assuming both actions (solar and lunar) to act on our magnets indirectly by exciting magnetic powers in the earth, which alone or principally are felt by the magnets, the earth itself may have gone through different stages of magnetic excitability, increasing or diminishing its competency to receive both the solar and the lunar action.

The epochs of lunar inequality in western declination from north and in horizontal force to magnetic north are sensibly the same; and the coefficients expressed in terms of horizontal force on the mean of all the years are sensibly the same, and equal to 0·000061. The direction of the composite disturbing force is therefore sensibly N.W. and S.E. magnetic, or (roughly) in the direction of a line from the Red Sea to the south of Hudson's Bay. It may be remarked in opposition to this that the solar diurnal action is mainly in the S.W. direction.

The luno-diurnal inequality of vertical force on the mean of all the years appears to consist of a luno-diurnal and a luno-semidiurnal term.

*December* 17, 1868.

Capt. RICHARDS, R.N., Vice-President, in the Chair.

The following communications were read:—